SOFTWARE COMPONENTS FOR AIR DEFENSE PLANNING

Major Arent Arntzen, Royal Norwegian Air Force
Master of Science in Operations Research-September 1998
Advisors: Visiting Assistant Professor Arnold H. Buss and Professor Gordon H Bradley

Modern offensive weapon technologies such as stealth and precision guided munitions have rendered Integrated Air Defense Systems increasingly vulnerable and ineffective. Since air defense is a purely reactive form of warfare, the application of scientific principles to the design and deployment of air defense systems is a major factor in achieving effectiveness. Today's air defense planners face rapidly changing technological developments, both for offensive weapons and for sensors. Understanding the impact of technology on air defense operations must be done continually and at an increasing pace. The combination of dwindling defense resources and rapid technological developments makes the need for analysis more critical. Yet with current software architectures, even the analysis activity may by prohibitively costly for small nations.

Major Arntzen was the 1998 recipient of the MORS/Tisdale Award. The Military Operations Research Society (MORS) sponsors the MORS/Tisdale Graduate Research Award for outstanding thesis work in the NPS Department of Operations Research. The award recognizes high quality research of immediate or near-term value to the Department of Defense.

Stealth effectively reduces the performance of radar, but does not have the same impact on passive systems. Sensors have been the most important and vulnerable part of air defense systems through the history of air warfare. Research into passive sensors has been encouraging, but before passive sensor systems are produced, procured and deployed, analysis and planning must be conducted to quantify potential benefit and determine feasible system configurations. As this type of analysis encompasses extremely complex systems behavior, developing reusable and flexible models becomes important.

Of all modeling tools available, system simulation is perhaps the only one capable of capturing the behavior of Integrated Air Defense Systems. Unfortunately, building and using a simulation model is an expensive, slow, and cumbersome activity. Since model abstractions must ultimately be turned into computer code, the productivity of a simulation modeling depends heavily on effective software engineering and programming.

Reuse is the key to increasing effectiveness in simulation modeling. Component Software is a technology that allows reuse of both model abstractions and implementations. Furthermore, this technology makes the simulation model scalable, allowing the analyst to start with a simple model and build towards higher complexity and fidelity. Building models using software components thus allows the analyst to develop a model in a series of stepwise refinements. Progressing in small steps using components, the analyst can derive the simplest possible model for the task at hand, minimizing the effort that goes into parts of the model that ultimately would not be used, thus increasing productivity.

This thesis uses Java, a new and powerful object-oriented programming language, to develop a prototype software component architecture and component library for building simulation models for air defense. Sensor and airborne weapon simulation components are demonstrated and used in an exploratory analysis of the impact of a network of Infrared Search and Track (IRST) sensors. A practical scenario comprising a modern medium range Surface-to-Air System (MSAM) is laid out as the basis for the simulation models. The data gathered from the models indicate that IRST systems could be valuable in the near future.

High tempo seems to be a dominating feature of theories of modern warfare. If simulation models are to be used for planning purposes under such circumstances the cycle time from one model to the next must be very short. Current methods fall far short of this requirement. In addition to providing model configuration flexibility and scalability, the component architecture supports reuse and makes data collection very simple. This thesis shows how these combined features can reduce modeling cycle-time dramatically in the context of air defense planning. Also, and of great interest to small nations, the high level of abstraction and reusability achieved by the component architecture may allow the functions of domain expert and simulation analyst to be combined in one individual.